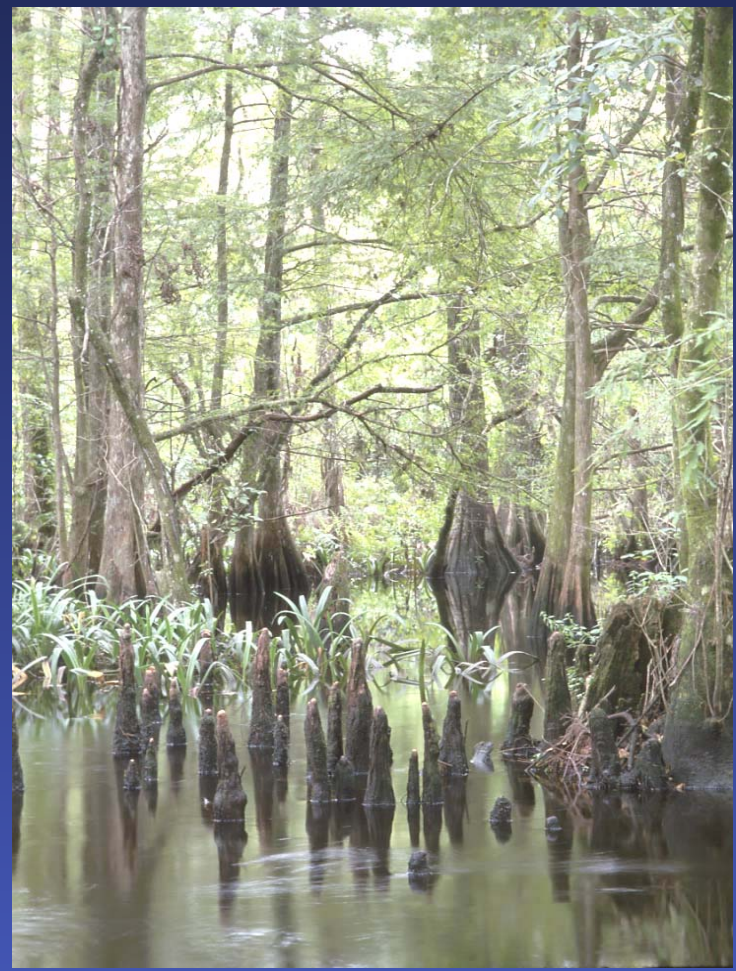
SOUTH FLORIDA WATER MANAGEMENT DISTRICT

MFL Criteria Development for the NW Fork of the Loxahatchee River



Water Supply Department
South Florida Water Management District

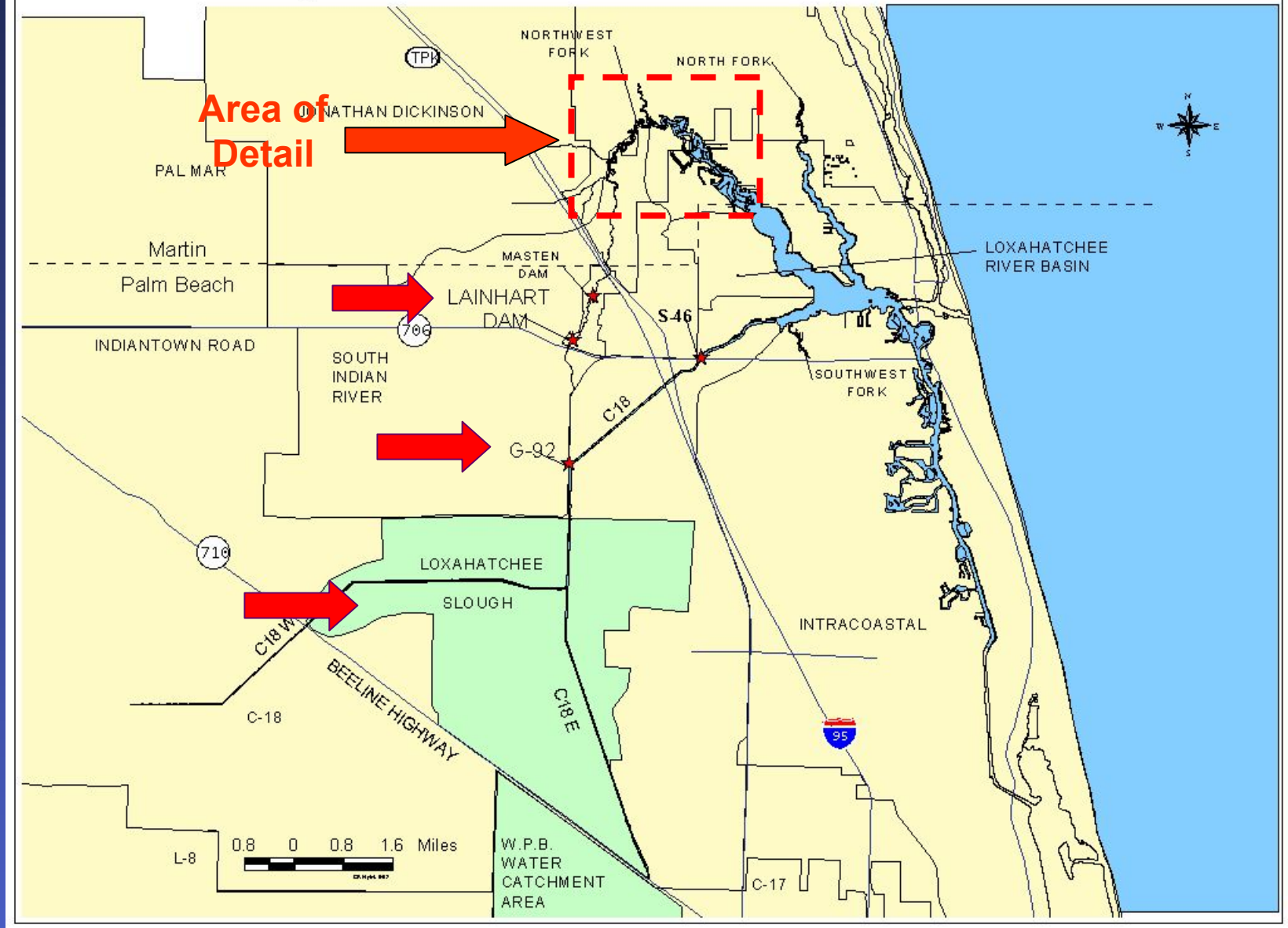
sfwmd.gov

Definitions

Minimum Flow - means the limit at which further withdrawals would be significantly harmful to the water resources of the area (section 373.042(1) F.S)

Significant Harm - means the temporary loss of water resource functions, which result from a change in surface or ground water hydrology, that takes more than two years to recover, but which is considered less severe than serious harm (CH. 40E-8.021(24), F.S.)

Major Features of the Loxahatchee Watershed



Major Tributaries of the NW Fork of the Loxahatchee River

History

- Historically, the Loxahatchee Estuary opened and closed to the Atlantic ocean as a result of natural causes (major floods, hurricanes)

- The estuary and lower river system oscillated between a freshwater and brackish water system in response to periodic opening and closing of the inlet.

Hydrologic and Structural Changes

- Permanent opening of the Jupiter Inlet (1947)
- Construction of the C-18 Canal and S-46 structure (1957-1958)
- Dredging of the inlet, estuary and lower portion of the NW Fork for navigation purposes (since the 1930's)
- Major roads (Beeline Highway, Northlake Blvd, Florida Turnpike, Bridge Road) intersect wetland flow ways that historically fed the NW Fork

Environmental Change

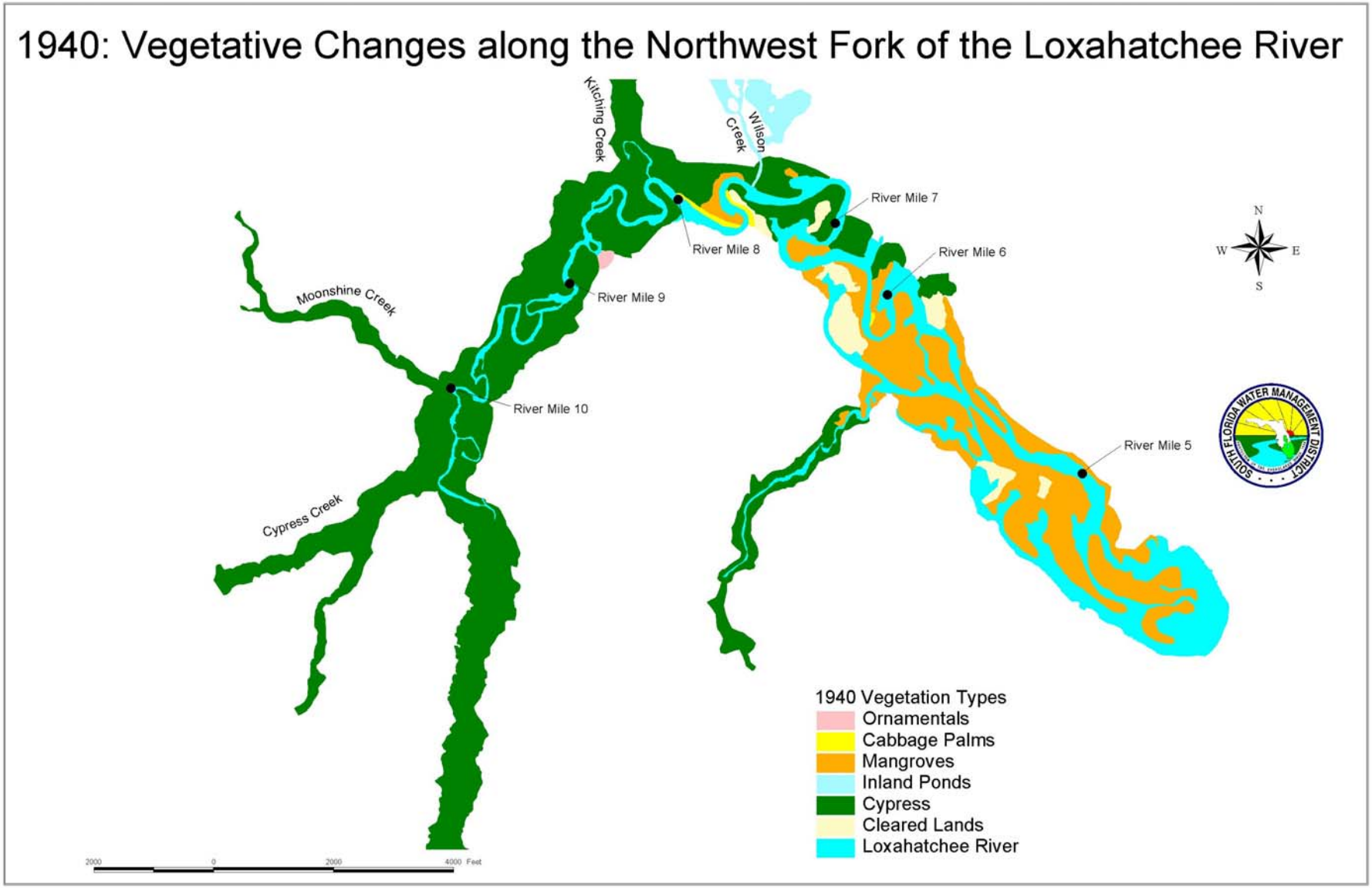
- By the 1970s it was recognized that these hydrologic changes have resulted in the upstream movement of saltwater during the dry season (Rodis 1973, Alexander & Crook 1975)

- These changes have slowly resulted in the loss of the lower portion of NW Fork's floodplain swamp due to saltwater encroachment - - the primary problem affecting the river

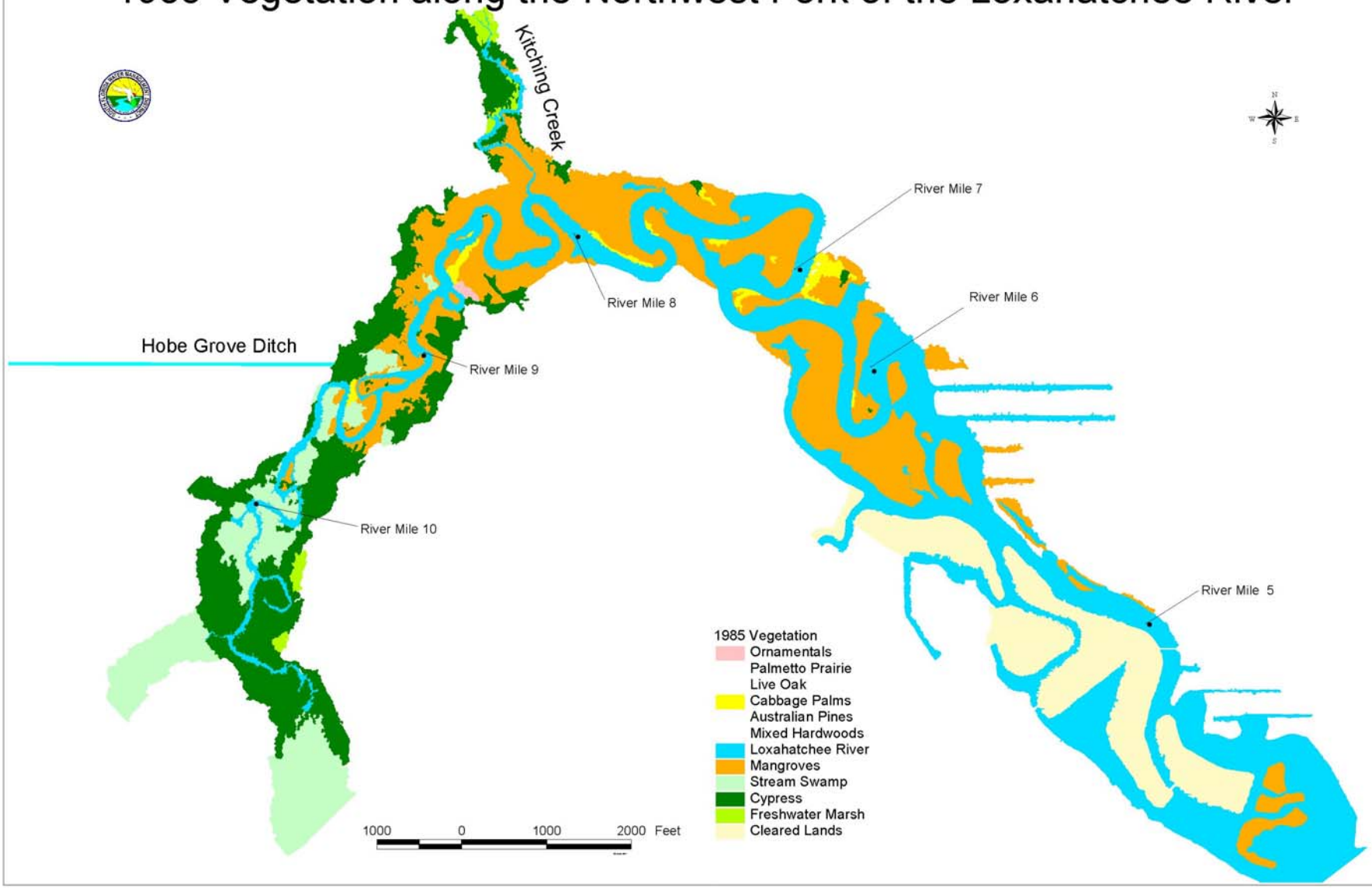
Upstream NW Fork - Unharmed, Healthy Floodplain Swamp

Downstream NW Fork- Mangroves, Cabbage Palm and dead Cypress snags

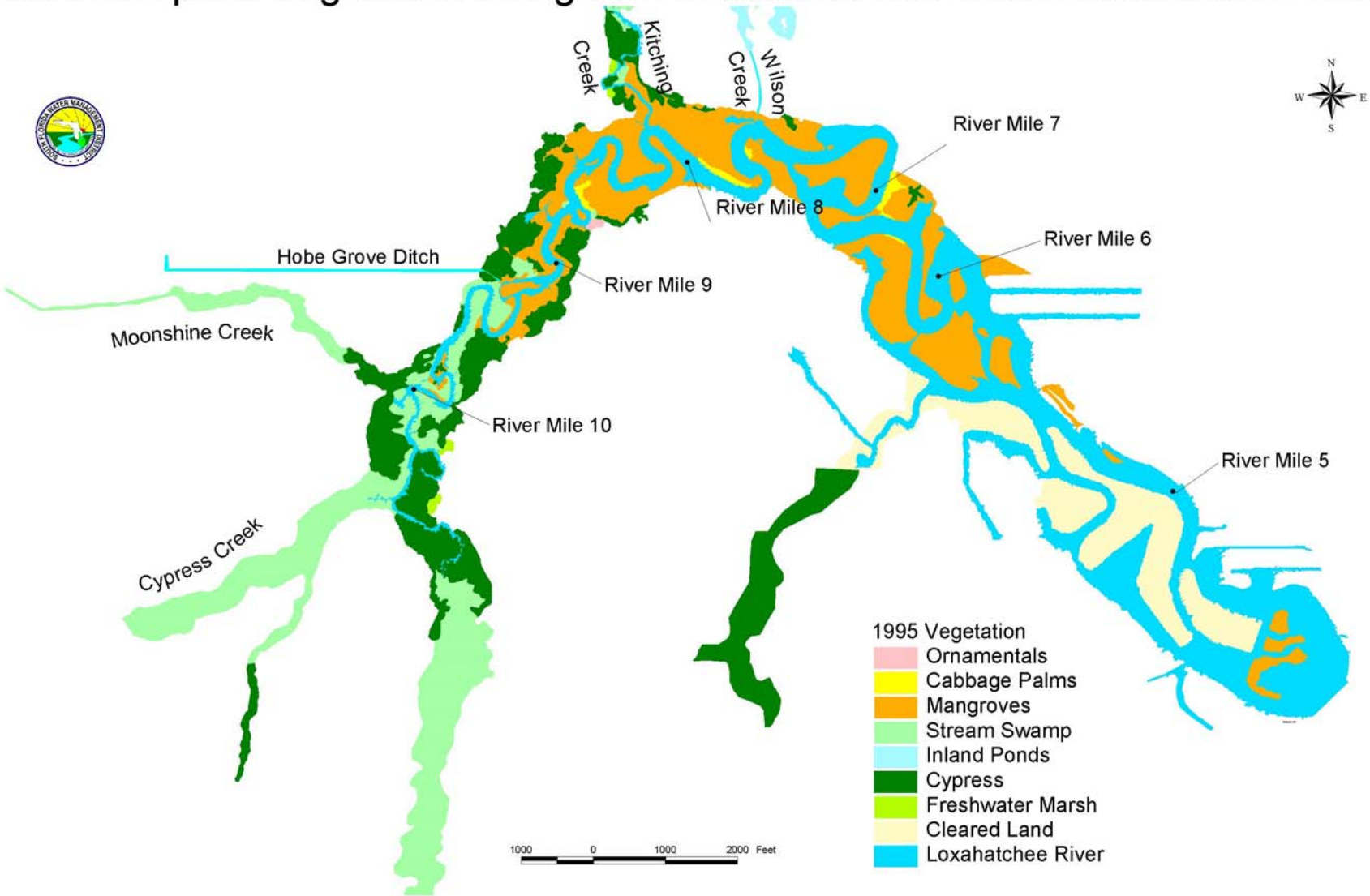
1940: Vegetative Changes along the Northwest Fork of the Loxahatchee River



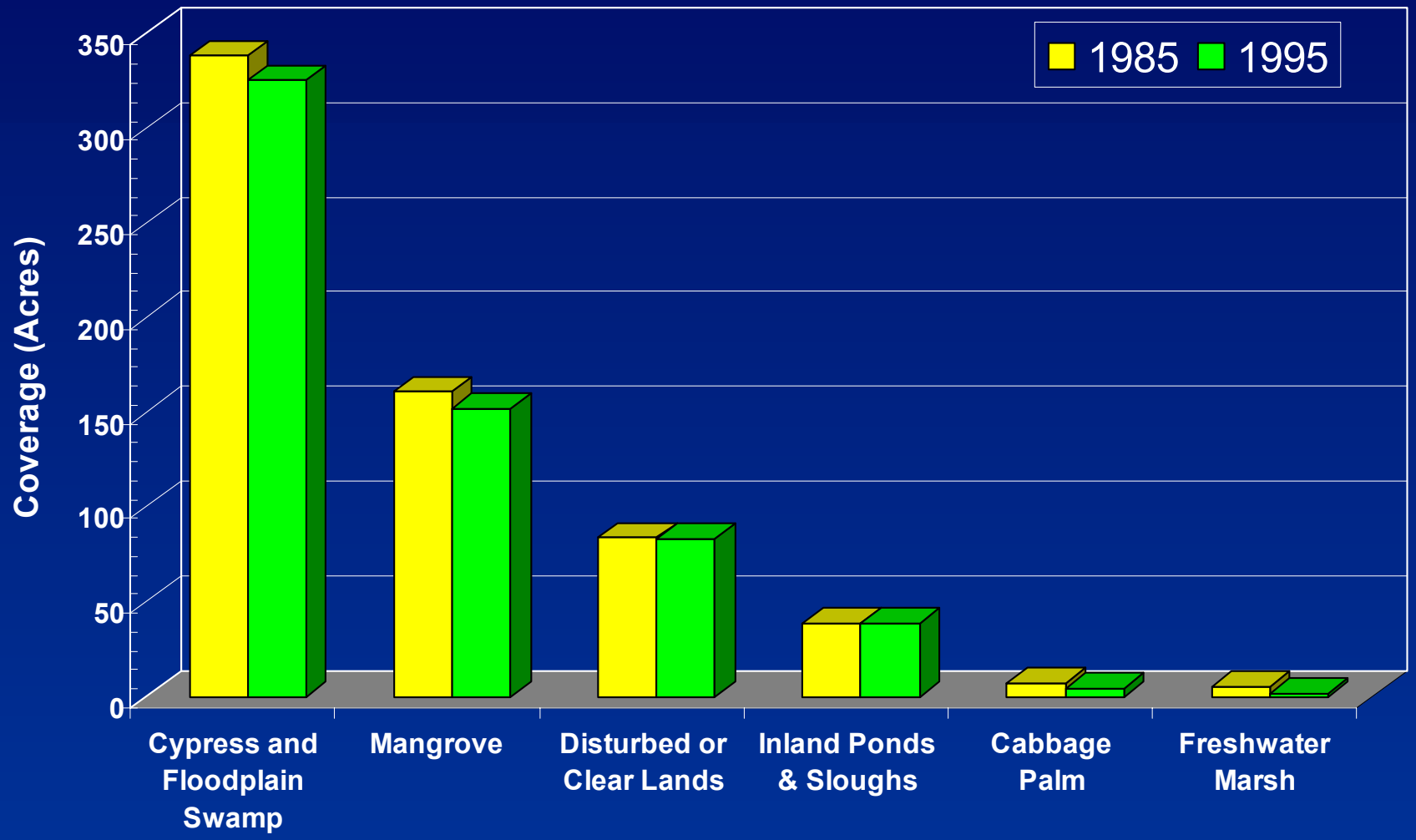
1985 Vegetation along the Northwest Fork of the Loxahatchee River



1995: Floodplain Vegetation along the Northwest Fork of the Loxahatchee River



1985 & 1995 River Vegetation Coverage
NW Fork, Loxahatchee River



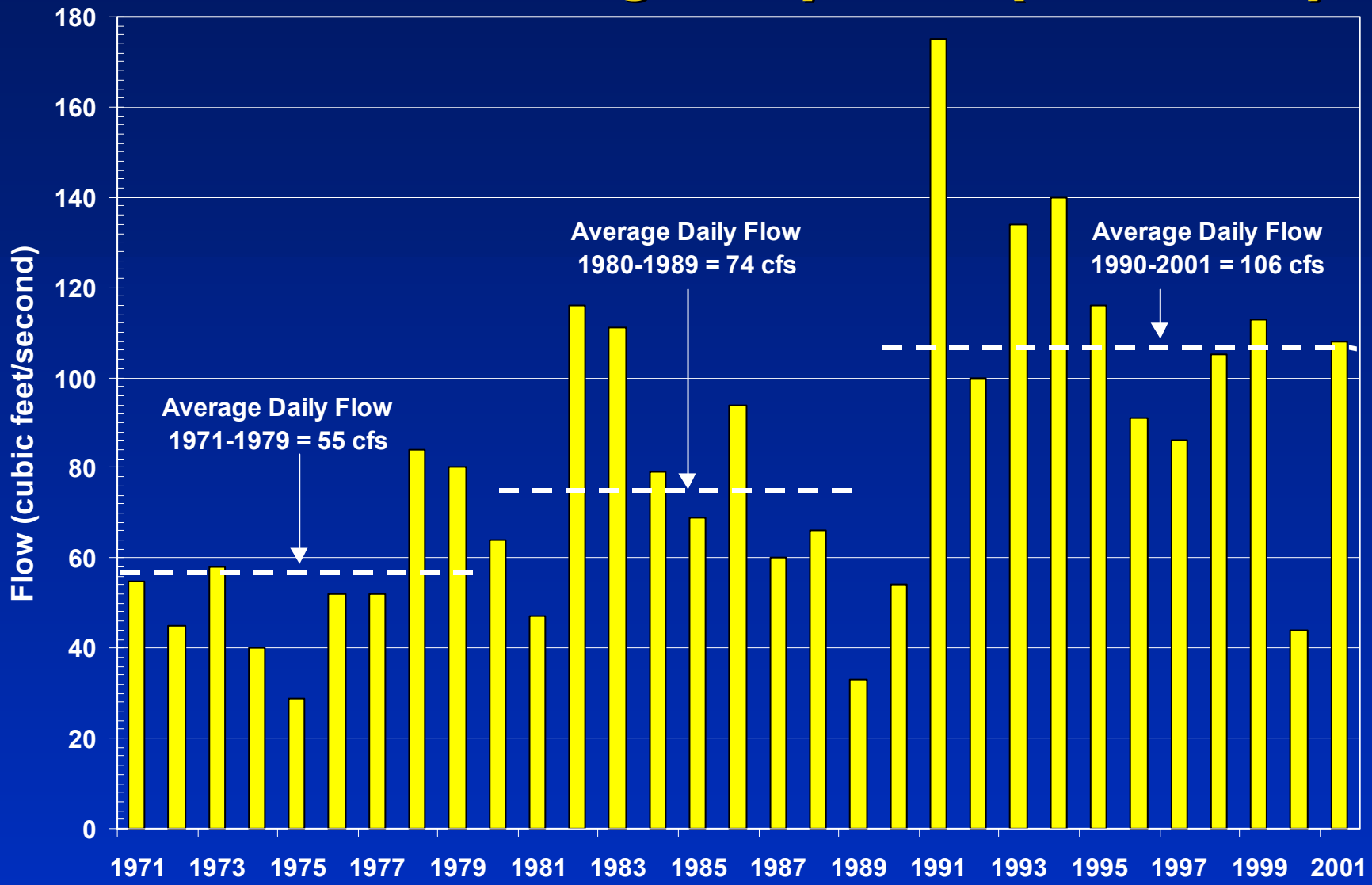
Hydrologic Improvements

- In 1974, the G-92 structure was constructed to re-divert water from the C-18 basin back to the Northwest Fork
- In 1982, agreements were made to provide a base flow of 50 cfs to the Northwest Fork subject to available water supply
- In 1985, the Loxahatchee River became the state's first federally designated "Wild and Scenic River"

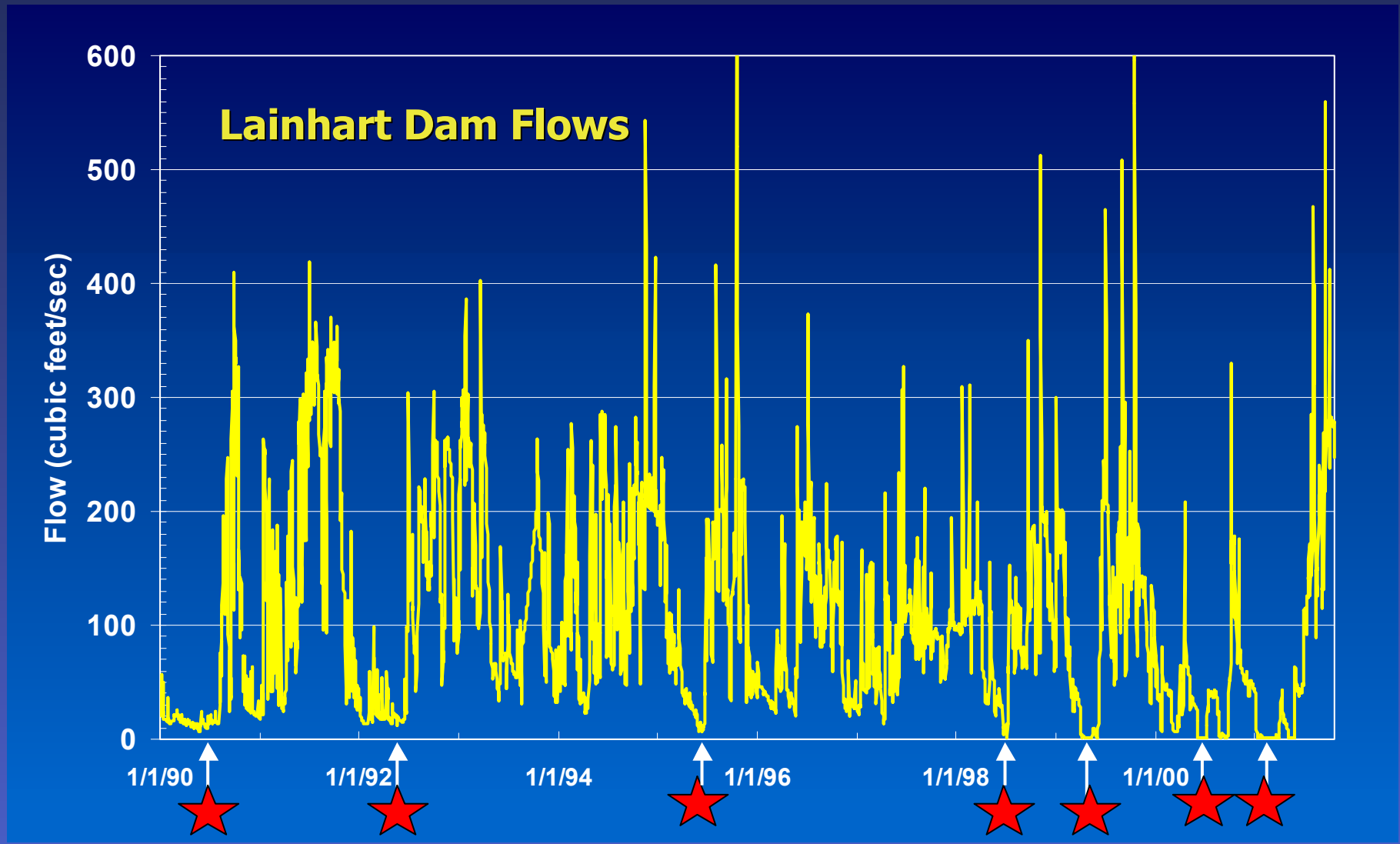
Hydrologic Improvements

- In 1987, the capacity of the G-92 structure was improved making it capable of passing up to 400 cfs to the NW Fork by remote telemetry
- These improvements, in combination with above normal rainfall, increased the volume of water delivered to the NW Fork over the last 12 years
- However, due the basin's limited water storage capacity, the river still experiences low flow periods 11 out of 12 years.

Lainhart Dam Average Daily Flows (1971-2001)



The Minimum Flow Problem



Average Surface Water Flows Delivered to the Loxahatchee Estuary from Major Tributaries

Tributary	Average Daily Flow (cfs)		1980-81 drought Avg. flow (cfs)		1989-90 drought Avg. Flow (cfs)		Period of Record
	Wet Season	Dry Season[1]	Wet Season	Dry Season	Wet Season	Dry Season	
Northwest Fork							
• **Lainhart Dam**	**95**	**70**	**65**	**35**	**68**	**26**	1971-2001
• Cypress Creek	60	32	57	30	41	30	1980-1991
• Hobe Grove Ditch	9	7	11	7	9	7	1979-1991
• Kitching Creek	21	16	8	5	3	1	1979-2001
Subtotal	***185***	***125***	***141***	***77***	***121***	***64***	
North Fork[2]							
USGS sites 28B, 28c	4	1	4	1	4	1	1980-1982
Southwest Fork							
C-18 Canal @ S-46	94	61	61	20	8	8	1961-2001
Total	***283***	***187***	***206***	***98***	***133***	***73***	

[1] Wet season defined as May 15- Oct. 15; Dry season = Oct. 16- May 14

[2] From Russell and McPherson 1984 (POR 1980-1982)

MFL Criteria Development (Methods)

District staff conducting a river vegetation survey

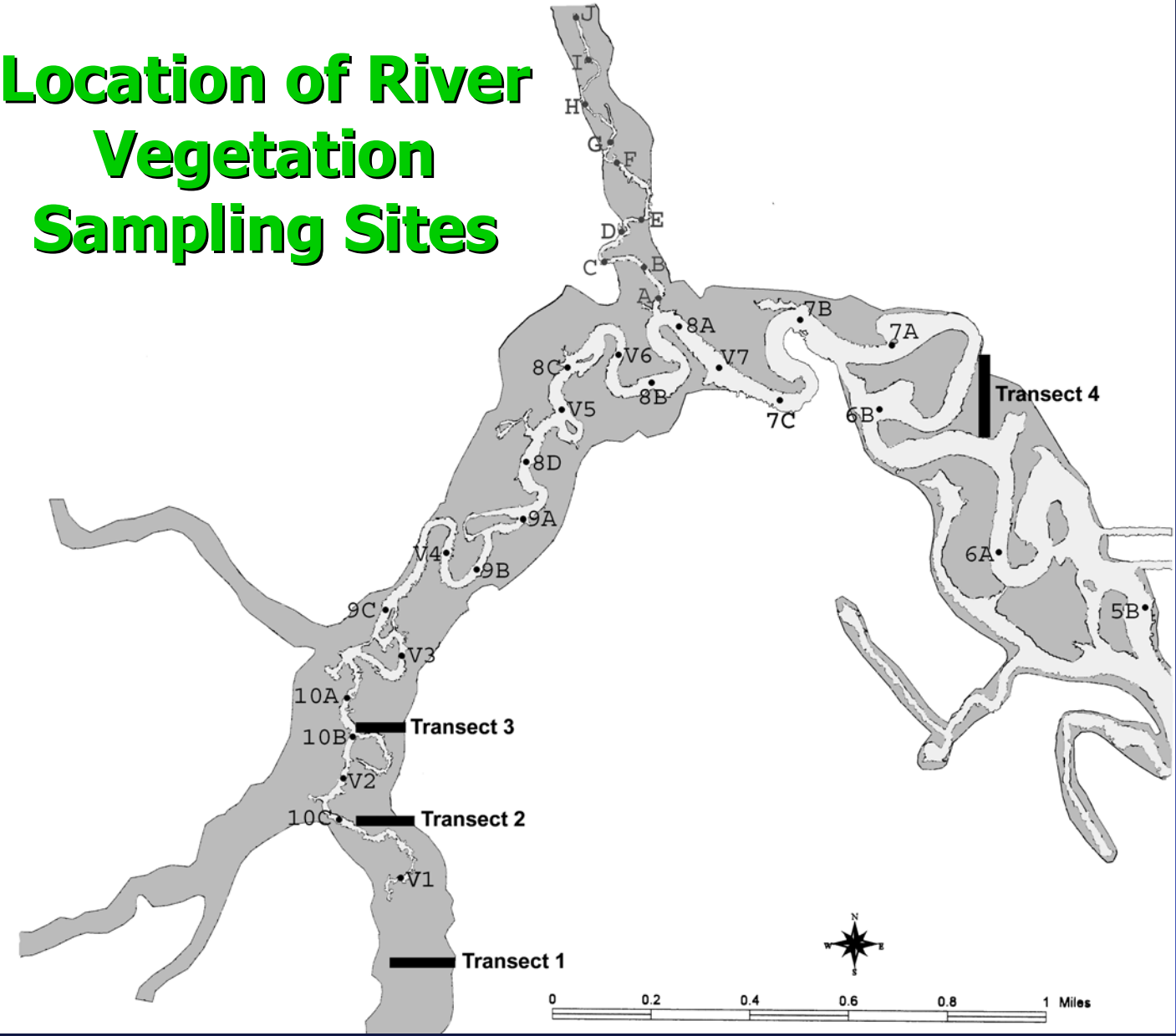
sfwmd.gov

SFWMD River Vegetation Survey

Determination of Indicator Species

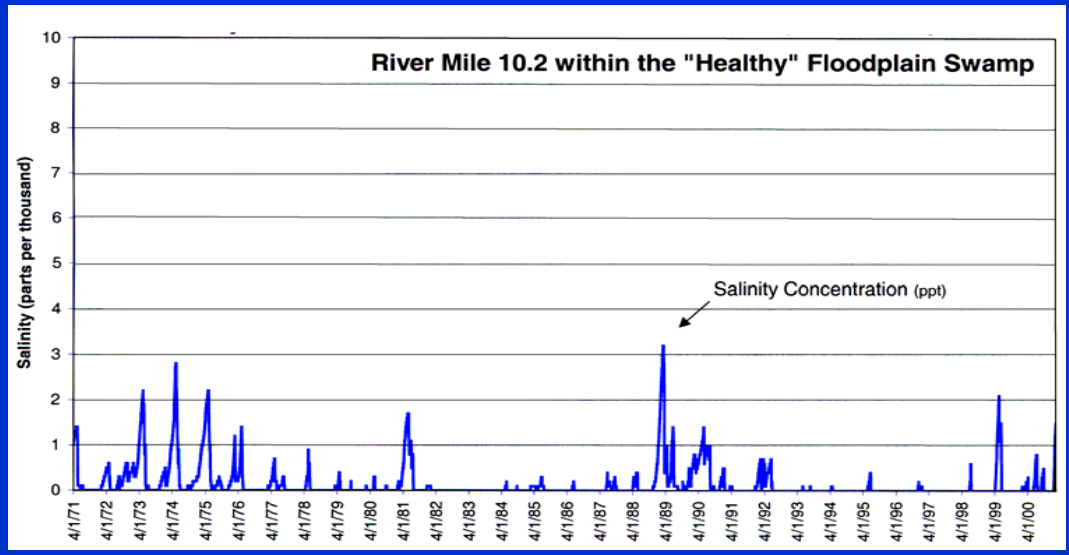
- Biological surveys were conducted to characterize river vegetation communities in relationship to the salinity gradient.
- Measured parameters included:
  - Percent canopy cover
  - Abundance
  - Total number of species
  - Tree height and trunk diameter
  - Presence of saplings or seedlings etc.
- These data were used to determine at what point in the river does “significant harm” occur

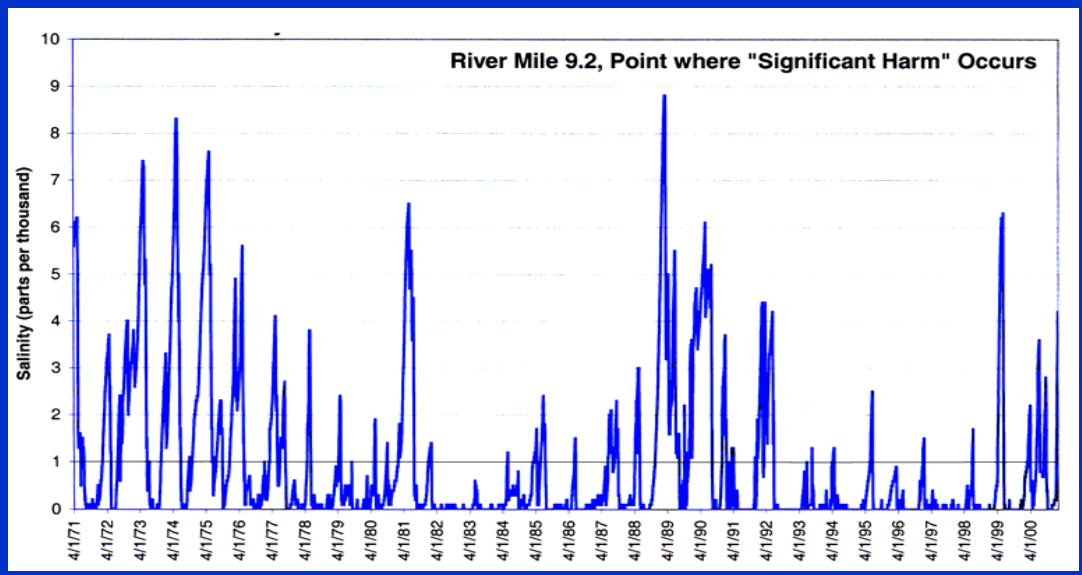
Location of River Vegetation Sampling Sites



Methods - Developing a Salinity Record

- Long-term (30 year) salinity records do not exist
- A 2-D hydrodynamic-salinity model (USACE, 1996) was used to hindcast a salinity time series for 7 selected river vegetation sites
- Model output was analyzed in terms relevant to a plant community:
  - Salinity Magnitude and Range (ppt)
  - Duration of a salinity event (days)
  - Return Frequency of a salinity event (how often does an event occur)





Simulated Salinity Time Series for River Miles 10.2 and 9.2

Source: 2-D Hydrodynamic/Salinity Model

River Vegetation Survey Results

Key Freshwater Indicator Species

Species	Saltwater Tolerance
Selected Indicator Species	
Red maple *(Acer rubrum)*	Freshwater[a]
Pop ash (*Fraxinus caroliniana*)	Freshwater[a]
Virginia willow (*Itea virginica*)	Freshwater[a]
Dahoon holly (*Ilex cassine*)	Freshwater[a]
Red Bay (*Persea borbonia*)	Freshwater[a]
Pond apple (*Annona glabra*)	Freshwater[a]
Other Dominant River Vegetation Species	
Bald cypress (*Taxodium distichum*)	Freshwater to slight salt tolerance[c]
Cabbage palm (*Sabal palmetto*)	Freshwater to slight salt tolerance[b]
Red mangrove (*Rhizophora mangle*)	Salt tolerant[a]

[a] see Tobe, et al. 1998.
[b] Cabbage palm is generally associated with freshwater and coastal swamps
[c] see Allen 1994; Allen et al. 1994, 1997; Conner 1992; Javanshir & Ewel 1993, Pezeshki et al. 1986, 1987, 1990, 1995

River Vegetation Survey Results

Measured Vegetation Parameter	Upstream → River Miles along Northwest Fork → Downstream							
	10.6	10.2	9.7	9.2	9.1	8.7	8.4	7.9
Presence/Absence of Key Species								
Percent Canopy Cover								
Presence of Seedlings & Saplings								
Number of Individuals								
Tree Height/Trunk Diameter								

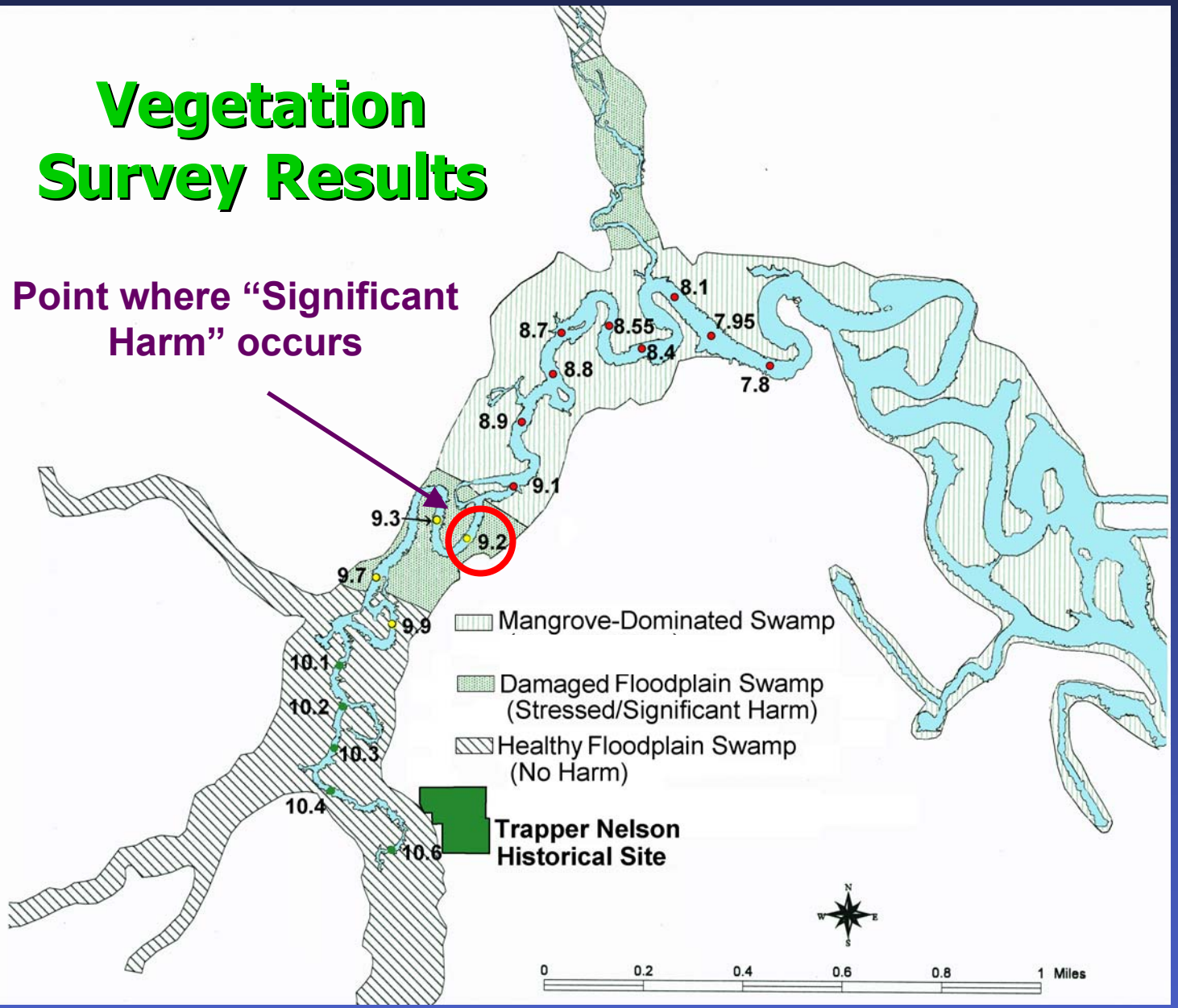
Healthy Floodplain Swamp

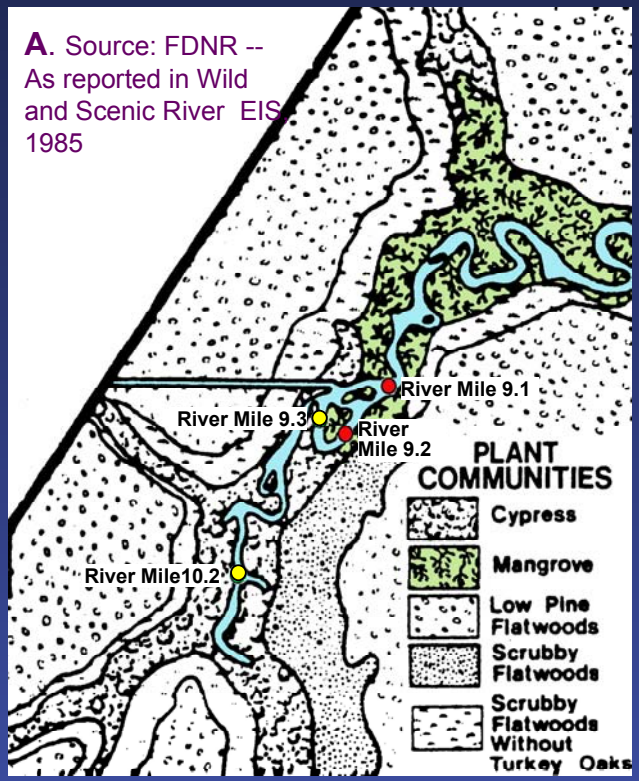
Observed Reduction in Parameter ("Stressed")

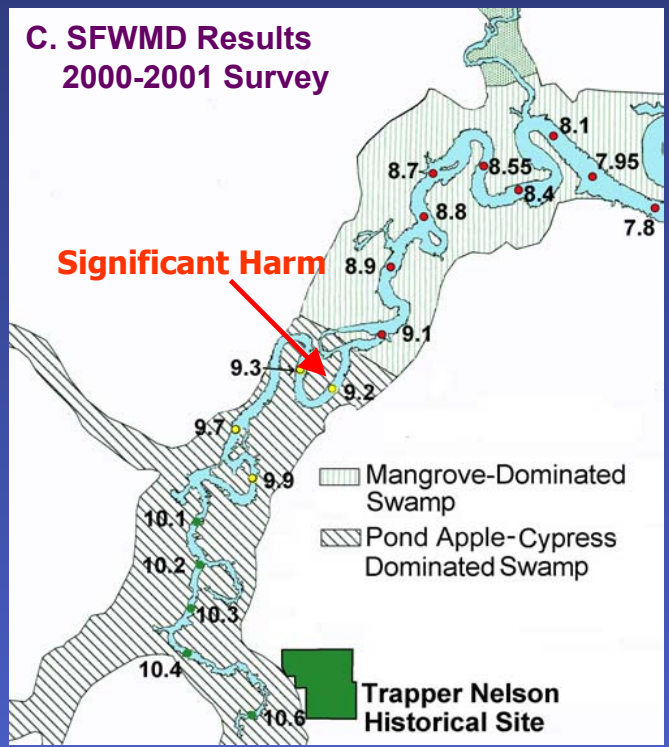
Loss of Freshwater Species or Functions (conversion to saltwater-tolerant mangroves)

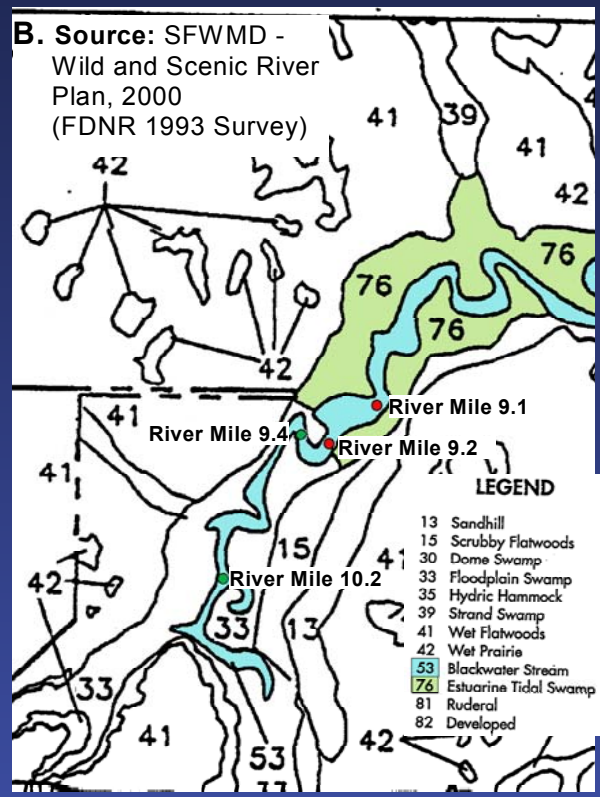
Vegetation Survey Results

Point where "Significant Harm" occurs




A. Source: FDNR -- As reported in Wild and Scenic River EIS 1985
River Mile 9.1
River Mile 9.3
River Mile 9.2
River Mile10.2
PLANT COMMUNITIES
Cypress
Mangrove
Low Pine Flatwoods
Scrubby Flatwoods
Scrubby Flatwoods Without Turkey Oaks


C. SFWMD Results 2000-2001 Survey
Significant Harm
8.1
8.7
8.55
7.95
8.4
8.8
7.8
8.9
9.1
9.3
9.2
9.7
9.9
10.1
10.2
10.3
10.4
10.6
Mangrove-Dominated Swamp
Pond Apple-Cypress Dominated Swamp
Trapper Nelson Historical Site

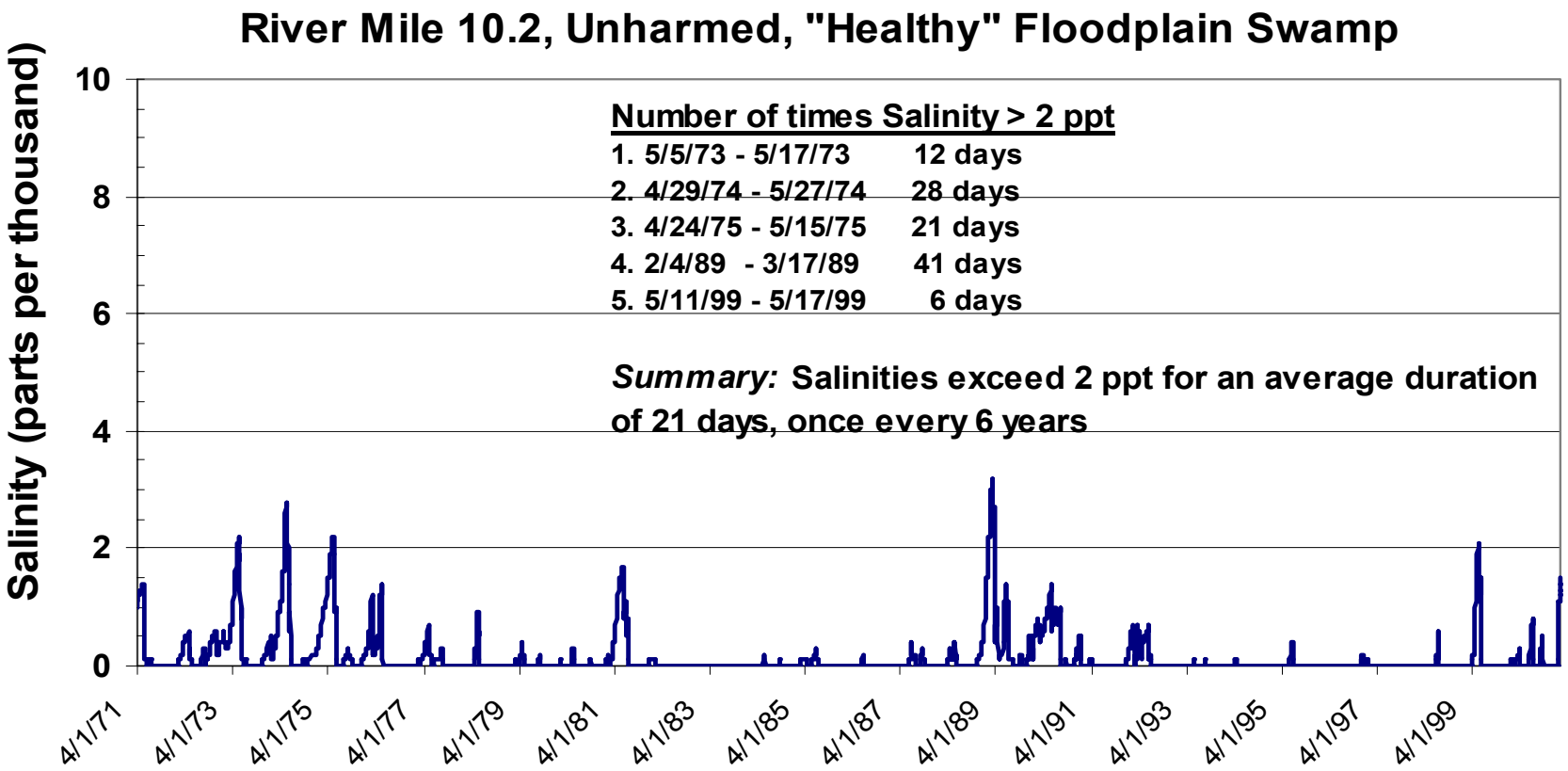

B. Source: SFWMD - Wild and Scenic River Plan, 2000 (FDNR 1993 Survey)
River Mile 9.1
River Mile 9.4
River Mile 9.2
River Mile 10.2
LEGEND
13 Sandhill
15 Scrubby Flatwoods
30 Dome Swamp
33 Floodplain Swamp
35 Hydric Hammock
39 Strand Swamp
41 Wet Flatwoods
42 Wet Prairie
53 Blackwater Stream
76 Estuarine Tidal Swamp
81 Ruderal
82 Developed

Resource Protection Criteria

- Provide a flow regime that will mimic average salinity conditions that exist at river mile 10.2 (the "healthy" Floodplain swamp) and transfer this flow regime downstream to river mile 9.2 to prevent significant harm

- Model results show that at RM 10.2, salinity should not exceed 2 ppt, for more than 20 days duration, more often than once every 6 years to maintain this community.

Hydrodynamic/Salinity Model Results



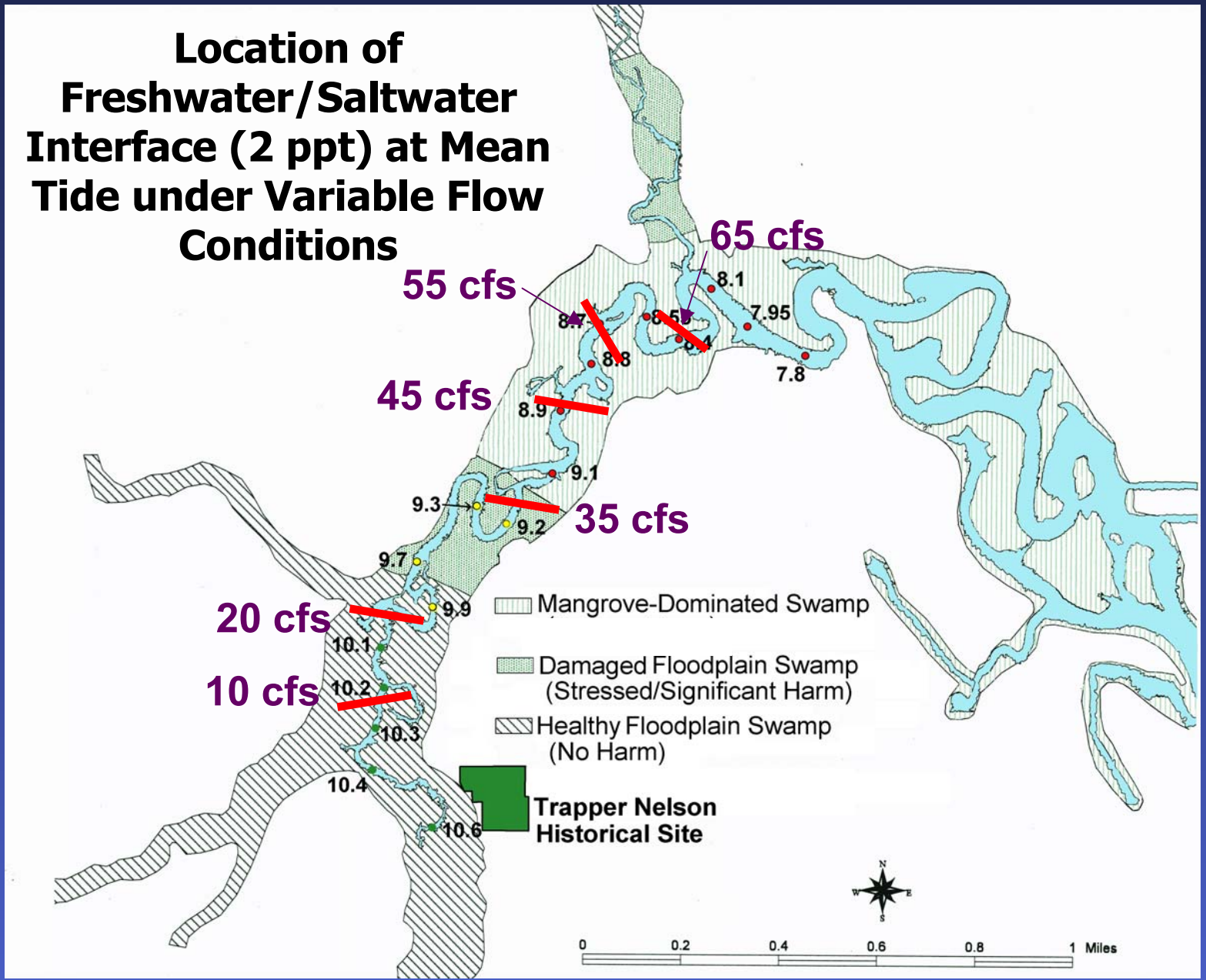
Flow/salinity relationships developed for the river indicate that flows within the 35 cfs range would be required to maintain average salinity levels at 2 ppt at river mile 9.2

Flow (cfs)	Mean Tide Salinity levels (ppt) [b]							
	RM 10.2	RM 9.7	RM 9.4	RM 9.2	RM 8.9	RM 8.6	RM 8.35	RM 7.7
65	0.1 [a]	0.2	0.2	0.3	0.7	1.3	1.9	4.2
55	0.1	0.3	0.4	0.6	1.1	2.0	2.8	5.5
50	0.1	0.3	0.5	0.8	1.3	2.3	3.3	6.2
45	0.2	0.4	0.7	1.1	1.8	2.9	4.0	7.1
40	0.2	0.6	0.9	1.4	2.2	3.5	4.7	8.0
35	0.3	0.9	1.3	1.9	2.9	4.4	5.7	9.2
30	0.4	1.1	1.8	2.5	3.6	5.3	6.7	10.4
20	0.8	2.3	3.3	4.2	5.6	7.7	9.3	13.1
10	2.0	4.7	5.9	7.2	8.8	11.2	12.8	16.6

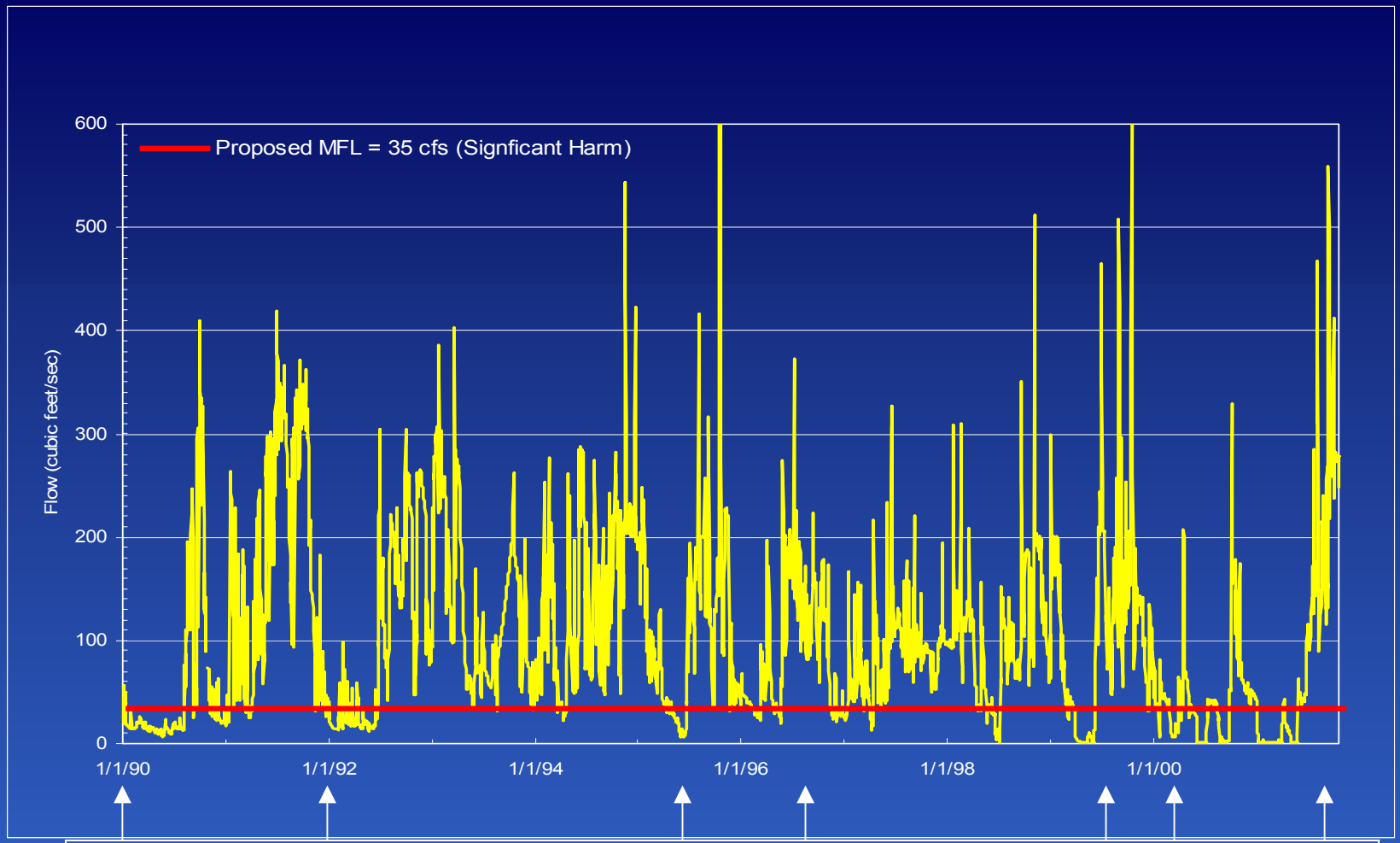
[a] Values represent mean tide salinity levels averaged for the entire water column

[b] Source: Models results from Loxahatchee River/estuary Hydrodynamic/salinity model

Location of Freshwater/Saltwater Interface (2 ppt) at Mean Tide under Variable Flow Conditions



Problem Definition: Lainhart Dam Flows (1990-2001)



Number of Days/year Lainhart Dam Flows were less than 35 cfs											
1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
264	32	153	6	20	60	88	33	48	84	151	142

Total 1,081

sfwmd.gov

Proposed MFL Criteria

- ***An MFL violation occurs within the NW Fork of the Loxahatchee River when an exceedance of the minimum flow criteria occurs more than once every six years. An "exceedance" is defined as when Lainhart Dam flows to the NW Fork decline below 35 cfs* for more than 20 consecutive days within any 365 day period.***

* **A flow of 35 cfs is equivalent to a recorded stage of 10.68 ft. NGVD as measured upstream of the Lainhart Dam at the SFWMD maintained gauge named "LNHART_W".**

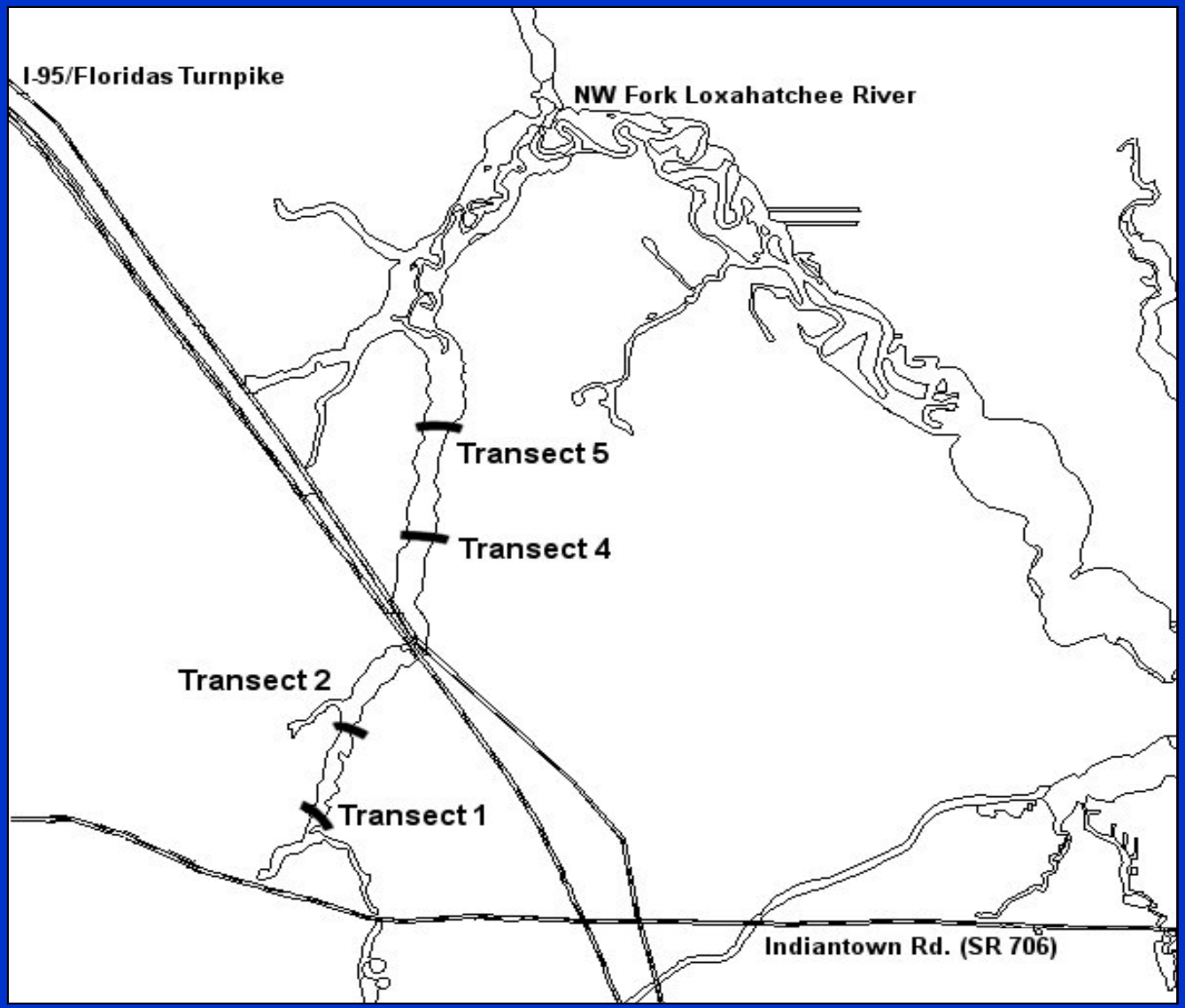
Estuarine Impacts

- Central Embayment Area – No adverse effects
- North Fork & SW Fork – No adverse effects
- Lower Portion of NW Fork – May provide more stable oligiohaline (1-5 ppt) habitat & improve dry season estuarine conditions that support oyster and seagrass communities

Basis: Review of Russell & McPherson (1984) data; 2-D hydrodynamic model output

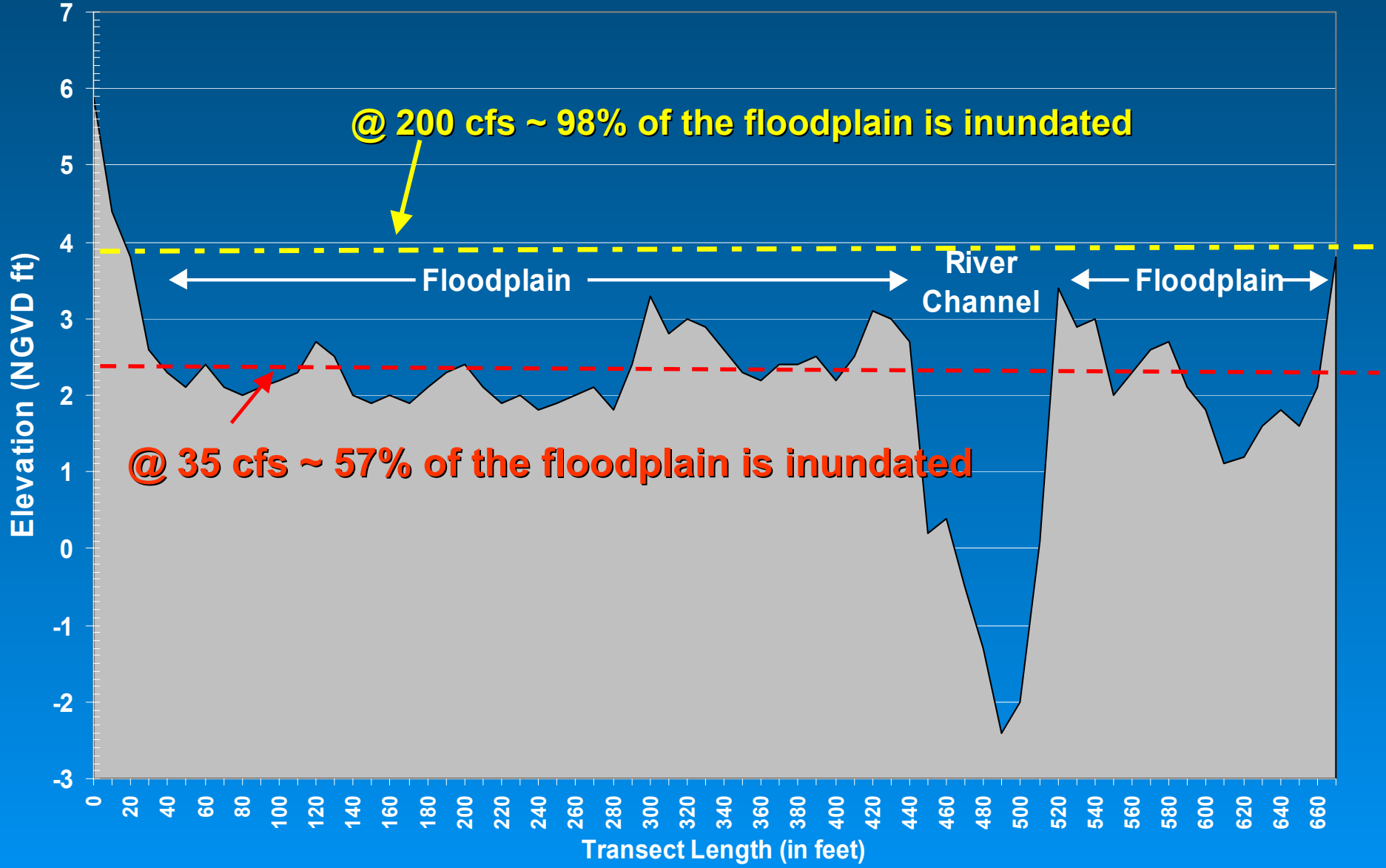
Effects of MFL on Floodplain Swamp:

- In setting an MFL to prevent saltwater intrusion, how does it relate to maintaining appropriate water levels & hydroperiods within the upstream Wild & Scenic portion of the river?



Location of Floodplain Transect Surveys (1984-1990)

Transect 5, Northwest Fork of the Loxahatchee River



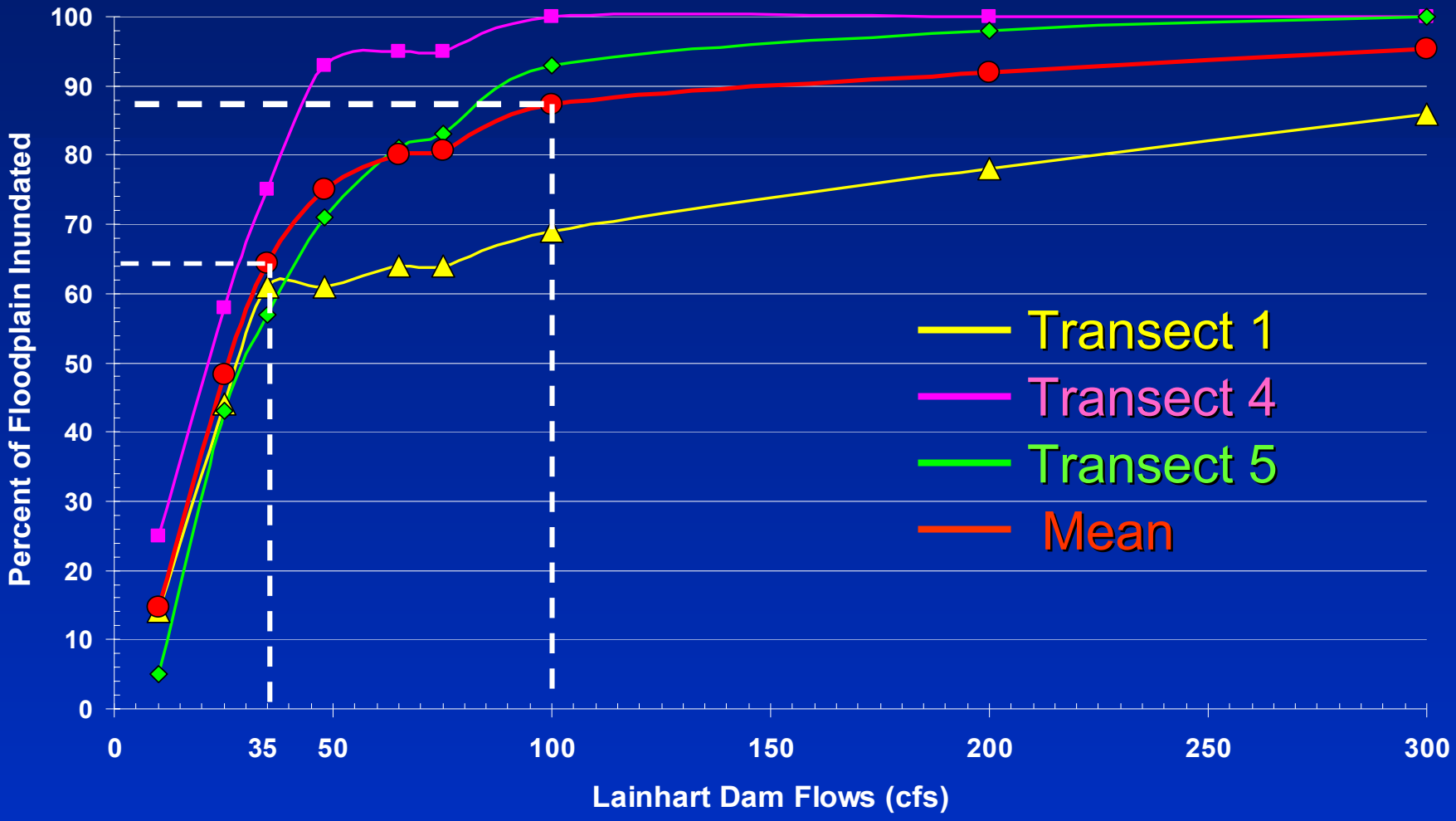
Relationship between Lainhart Dam Flows and Percent of the Floodplain Swamp Inundated

Name	Lainhart Dam Flows							
	10 cfs	25 cfs	35 cfs	65 cfs	75 cfs	100cfs	200cfs	300cfs
Transect 1	14%*	44%	61%	64%	64%	69%	78%	86%
Transect 2**	0%	7%	16%	49%	53%	74%	86%	91%
Transect 4	25%	58%	75%	95%	95%	100%	100%	100%
Transect 5	5%	43%	57%	81%	83%	93%	98%	100%
Avg.(Transects 1, 4, and 5)	15%	48%	64%	80%	81%	87%	92%	95%

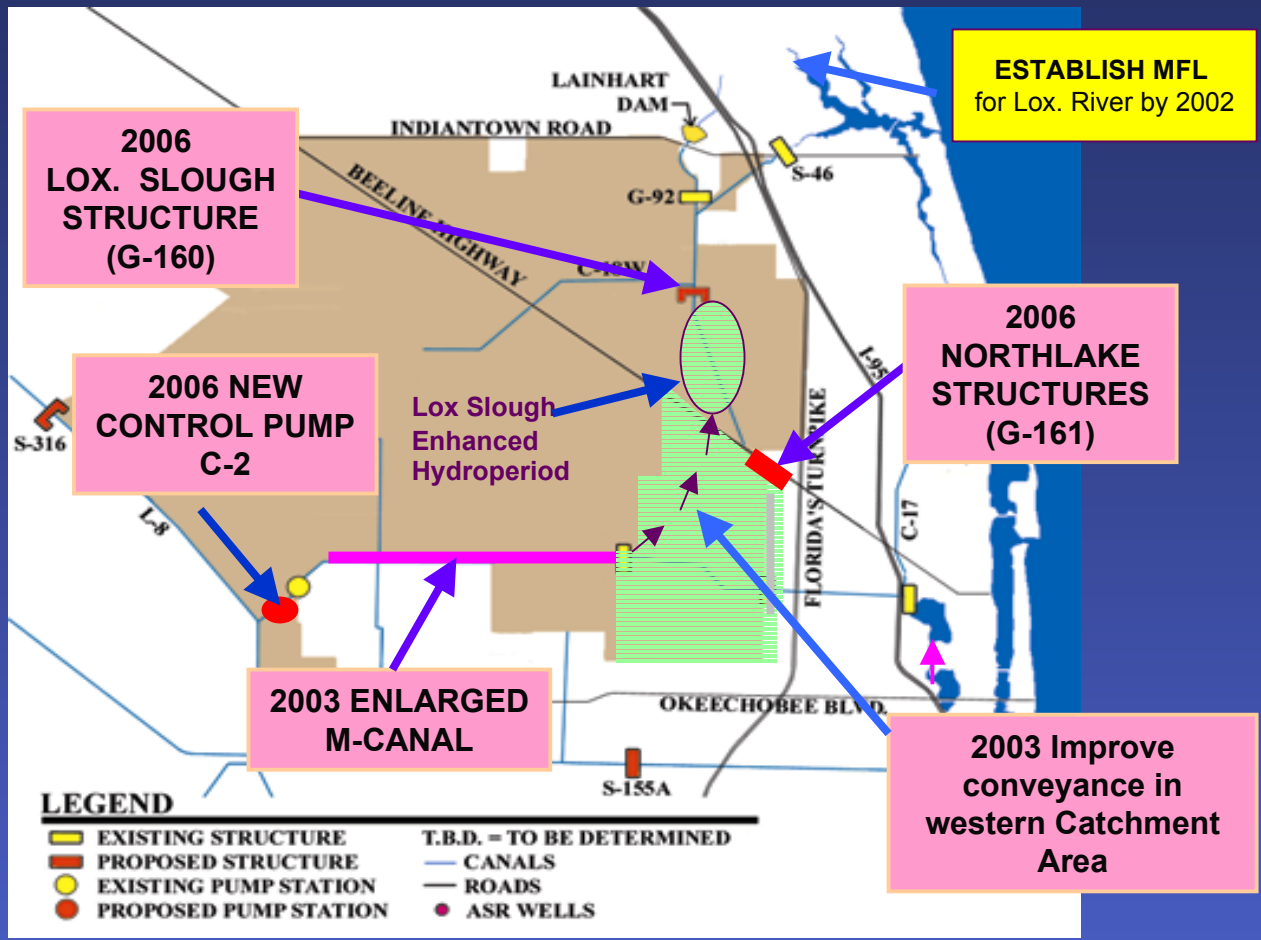
* = Percent of the floodplain inundated

** = Transect 2 is located just downstream from the Masten Dam and is heavily influenced by that structure. For this reason, Transect 2 was not included in these analyses.

Lainhart Dam Flows vs. Percent of Floodplain Inundated



Loxahatchee MFL Recovery Plan Phases 1- 2 (by 2006)



MFL Recovery Plan (con't)

Phase 3 (2011-2014)

- Water Catchment Area perimeter canal improvements (2011)
- Capture J.W. Corbett WMA runoff for storage within Loxahatchee Slough (2011)
- Construction of L-8 reservoir - adds 48,000 ac-ft of storage capacity (2014)

Phase 4 (2018)

- Construction of 10, 5 MGD ASR wells (50 MGD injection capacity) to increase basin storage

Percent of Time Loxahatchee River Flow Targets are Met: Current & Future Conditions

Flow Target	1995 Base Case (without improvements)	2006 (with G-160 + G-161)	2018 (with all NPCCWMP projects on line)
65 cfs	41%	70%	99.2%
50 cfs	46%	81%	99.4%
35 cfs	51%	94%	100%
20 cfs	56%	99%	100%
10 cfs	80%	99.1%	100%
5 cfs	94%	100%	100%

Source: Model results from the Northern Palm Beach County Comprehensive Water Management Plan

Summary

- The proposed criteria are consistent with the development of MFL criteria adopted for the Everglades, Lake Okeechobee, Biscayne aquifer, and the Caloosahatchee and St. Lucie estuaries
- By 2006, the proposed MFL criteria will only fall below 35 cfs for 20 days duration, once every 6 years -- a major improvement over current conditions
- The District will continue to implement the water delivery policy that has been in effect since 1985, to provide 50 cfs of base flow from G-92 to the NW Fork when available

Loxahatchee MFL Rule Development Schedule

Sept - Nov.	Revise Final Draft, Prepare Draft Rule Language
Nov. 4	Water Resources Advisory Commission
Nov. 14	GB meeting - Present peer review comments & schedule for Rule Development workshops
Nov. 15	Mail out final draft of MFL Technical Document
Nov. 18	Loxahatchee River Coordinating Council
Nov. 19	**Rule Development Workshop** (Clayton Hutchinson Bld., 2- 4 p.m., WPB)
Nov. 21	**Rule Development Workshop** (Jupiter Town Hall, 5:30-7:30pm)
Dec. 9	**Rule Development Workshop** 9 am - 5 p.m., WBP (exact location to be determined)
Dec. 12	**GB meeting to approve Technical Criteria, authorize publication of Final Rule in F.A.W.**
Feb. 13	**GB Public Hearing to adopt Rule**